

Remarks

Thorough examination by the Examiner is noted and appreciated.

Claim Rejections under 35 USC 103

1. Claims 1, 3, 5-10 and 16-20 stand rejected under 35 USC 103(a) as being unpatentable over Edelstein et al. (US 6,251,787 or 6,153,043), in view of Chang et al (US 6,323,131), Zhang et al. (6,162,301), Kneer (US 6,147,002) and the state of the art allegedly admitted by Applicants in the Specification (pages 6-7, especially paragraph 009).

Note that column and line number citations are with respect to Edelstein et al. '787, though the same disclosure is found in '043.

Edelstein et al. disclose and teach **eliminating exposure of PN junctions to light** capable of invoking a **photovoltaic reaction** to prevent electrochemical dissolution of metal components in contact with an electrolyte (see Abstract; col 5, lines 25-34).

Edelstein et al. further teach that PN junctions are formed by introducing impurity atoms into areas of a semiconductor wafer

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(col 5, lines 10-13) and further teach that **exposure of the PN junctions** to light of certain wavelengths essentially acts as a battery supplying current to metal interconnects (col 5, lines 29-34) which, when **in contact with an electrolyte** can lead to **electrochemical dissolution** of the metal. Edelstein teaches eliminating exposure of **semiconductor PN junctions** to light having wavelengths less than about 1.1 micron for **silicon wafers** and 0.9 microns for **GaAs wafers** (col 5, lines 52-59).

Edelstein does not teach Applicants disclosed and claimed invention including:

"shielding the exposed copper oxide containing surface and the acidic cleaning solution to substantially block incident light from impacting on the exposed copper oxide containing surface and the acidic cleaning solution while contacting the exposed copper oxide containing surface with the acidic cleaning solution to remove the copper oxide."

Moreover, Edelstein et al. do not recognize or appreciate the required acidity (pH) of an acidic copper oxide removing (cleaning) solution or the **photo-induced chemical attack** that occurs in the circumstances of exposing **copper oxide which is contacting copper in the presence an acidic cleaning solution of a particular pH to light of selected wavelengths**, which Applicants have shown is an unexpected effect by presentation of

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experimental results in the Specification. In the method of Edelstein et al., **PN junctions are required to be illuminated to cause a corrosive action on copper.**

Edelstein et al. simply does not teach suggest or disclose Applicants disclosed and claimed invention including the recognition of the source of a problem and a solution thereto. Edelstein et al.'s disclosed mechanism of operation (**exposure of PN junctions**) together with disclosed wavelengths of light that are beyond (longer than) Applicants disclosed wavelengths, and where no lower limit of wavelengths is taught, is inconsistent with Applicants disclosed and claimed invention. For example, light shielding according to the teachings of Edelstein et al. would conceivably be needed from only the back or front or portions of a process wafer surface and would not require the presence of copper oxide or the particular pH of an electrolyte (acidic solution) as Applicants have disclosed and claimed. Rather, the presence of copper oxide overlying and contacting the copper of Edelstein et al. would likely act as a **protective layer** preventing electrochemical dissolution of copper, **defeating the purpose and principal of operation of the method of Edelstein et al.**

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For example, the wave lengths of light disclosed and claimed by Applicants would likely not penetrate through a dielectric layer or a backside of a semiconductor substrate (e.g., 300 nm - 800 nm) to expose a PN junction as required in the method of Edelstein et al.

Thus, the principal of operation of the method and teachings of Edelstein et al. is different in operation and effect than the method and principal of operation of Applicants disclosed and claimed invention. Edelstein et al. do not recognize the source of the problem or a solution to the problem recognized and solved by Applicants.

The disclosure of Applicant, as the experimental section makes clear, is a method for preventing **photo-induced chemical attack** on copper **during a copper oxide removal process** at the relevant pH's disclosed and claimed. Applicants have discovered an unexpected result in a particular pH range for an acidic cleaning solution in contact with copper oxide overlying and contacting copper under the specified claimed conditions **during** a copper oxide removal process.

In summary, the problem and solution taught by Edelstein et al. operates by a different principal of operation and arises

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from a different source, requiring different solutions, and would not solve the problem that Applicants have recognized and solved.

"A prior art reference must be considered in its entirety, i.e., as a whole including portions that would lead away from the claimed invention."

W.L. Gore & Associates, Inc., Garlock, Inc., 721 F.2d, 1540, 220 USPQ 303 (Fed Cir. 1983), cert denied, 469 U.S. 851 (1984).

"If the proposed modification or combination of the prior art would change the principle of operation of the prior art invention being modified, then the teachings of the references are not sufficient to render the claims *prima facie obvious.*" *In re Ratti, 270 F.2d 810, 123, USPQ 349 (CCPA 1959).*

"[A] patentable invention may lie in the discovery of the source of a problem even though the remedy may be obvious once the source of the problem is identified. This is part of the 'subject matter as a whole' which should always be considered in determining the obviousness of an invention under 35 U.S.C. § 103." *In re Sponnoble, 405 F.2d 578, 585, 160 USPQ 237, 243 (CCPA 1969).*

Obeng et al. teach "a ULSI circuit chip comprising copper interconnects with a corrosion protection layer of the surface of the copper which layer is comprised of a self assembled organic monolayer "to prevent corrosion of the copper during CMP and post CMP cleaning conditions (see col 3, lines 60-64). Obeng et al teach a post CMP cleaning process with CO₂ sparged deionized water having a pH of about 4.

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There is no apparent motive for combining Obeng et al. with Edelstein et al., other than Applicants disclosure, as Examiner has found necessary to do below. For example, Obeng et al. do not disclose or suggest a photo-voltaic induced erosion of copper in contact with a PN junction as disclosed in Edelstein et al. or photo-induced chemical attack of copper in the presence of copper oxide during a copper oxide removal process as Applicants have disclosed and claimed.

Even assuming *arguendo*, proper motivation for combining references, such combination does not produce Applicants disclosed and claimed invention. The fact that acidic cleaning solutions are known in the prior art does not help Examiner in making out a *prima facie* case of obviousness with respect Applicants disclosed and claimed invention.

The fact that references relied upon teach that all aspects of the claimed invention were individually known in the art is not sufficient to establish a *prima facie* case of obviousness without some objective reason to combine the teachings of the references. *Ex parte Levengood*, 28 USPQ2d 1300 (Bd. Pat. App. & Inter. 1993).

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With respect to Applicants alleged admitted state of the prior art, Applicants discuss the prior art and the problem presented in the prior art (see paragraph 009), including the fact that an acidic cleaning solution used to remove copper oxide **can accelerate** the erosion of copper, a problem that Applicants disclosed and claimed invention solves. Thus, the combination of Obeng et al. with Edelstein et al. is improperly motivated by reference to Applicants disclosure. Nevertheless, such combination does not produce Applicants disclosed and claimed invention nor recognize the source of the problem that Applicants have recognized and solved.

Zhang et al. also teach an acidic cleaning solution for cleaning a wafer surface post-CMP following polishing a copper layer (see Abstract).

The same comments made above with respect to Obeng et al., apply to Zhang et al. There is no apparent proper motivation for combining Zhang et al. with Edelstein et al. except for Applicants disclosure which provides recognition of a problem, identifies the source of the problem, and provides a solution. Therefore Examiner improperly has used Applicants disclosure as a roadmap in attempting to recreate Applicants disclosed and claimed invention.

There is no teaching or suggestion in Zhang et al. that a post CMP cleaning process with an acidic cleaning solution may be related to a photovoltaic induced erosion of copper as taught by Edelstein et al. or a photo-induced chemical attack of copper during a copper oxide cleaning process as disclosed and claimed by Applicants. Even assuming *arguendo* proper motivation for combination, such combination fails to produce Applicants disclosed and claimed invention or recognizes or solves the problem that Applicants have recognized and solved by their disclosed and claimed invention.

With respect to Kneer et al., Applicants reiterate the above comments made with respect to Zhang et al. and Obeng et al. Kneer et al.; also disclose an acidic cleaning solution for cleaning copper **following** CMP planarization. Moreover, Kneer et al. teaches a cleaning solution that **slightly etches the copper** (see col 4, lines 54 - 65), taught to be desirable to remove contaminants. There is no recognition or discussion in Kneer et al. that an acidic cleaning solution may be related to a photovoltaic induced erosion of copper as taught by Edelstein et al., or a photo-induced chemical attack of copper **in the presence of copper oxide and the acidic cleaning solution during copper oxide removal** as disclosed and claimed by Applicants. Kneer et al., alone or in combination with Edelstein et al., or any of the

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other cited references recognizes the source of the problem or provides a solution to the problem Applicants have recognized and solved by their disclosed and claimed invention; "A method for preventing **photo-induced chemical attack** on a copper interconnect **during** removal of an overlying copper oxide containing surface".

Nevertheless, even assuming *arguendo* proper motivation for combining the references of Obeng et al., Zhang et al., Kneer et al., the references singly or in any combination fail to produce Applicants claimed invention or recognize or solve the problem that Applicants have recognized and solved by their disclosed and claimed invention.

"Finally, the prior art reference (or references when combined) must teach or suggest all the claim limitations. The teaching or suggestion to make the claimed combination and the reasonable expectation of success must both be found in the prior art, and not based on applicant's disclosure." *In re Vaeck*, 947 F.2d 488, 20 USPQ2d 1438 (Fed. Cir. 1991).

When applying 35 U.S.C. 103, the following tenets of patent law must be adhered to:

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- (A) The claimed invention must be considered as a whole;
- (B) The references must be considered as a whole and must suggest the desirability and thus the obviousness of making the combination;
- (C) The references must be viewed without the benefit of impermissible hindsight vision afforded by the claimed invention; and
- (D) Reasonable expectation of success is the standard with which obviousness is determined.

Hodosh v. Block Drug Co., Inc., 786 F.2d 1136, 1143 n.5, 229 USPQ 182, 187 n.5 (Fed. Cir. 1986).

Applicants point out that "we do not pick and choose among the individual elements of assorted prior art references to recreate the claimed invention, but rather we look for some teaching or suggestion in the references to support their use in a particular claimed combination" *Symbol Technologies, Inc. v. Opticon, Inc., 935 F.2d 1569, 19 USPQ2d 1241 (Fed. Cir. 1991)*.

"The mere fact that references can be combined or modified does not render the resultant combination obvious unless the prior art also suggests the desirability of the combination." *In re Mills, 916 F.2d 680, 16 USPQ2d 1430 (Fed. Cir. 1990)*

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"[A] patentable invention may lie in the discovery of the source of a problem even though the remedy may be obvious once the source of the problem is identified. This is part of the 'subject matter as a whole' which should always be considered in determining the obviousness of an invention under 35 U.S.C. § 103." *In re Sponnoble*, 405 F.2d 578, 585, 160 USPQ 237, 243 (CCPA 1969).

The claims have been amended to clarify Applicants invention. A favorable reconsideration of Applicants' claims is respectfully requested.

Based on the foregoing, Applicants respectfully submit that the Claims are now in condition for allowance. Such favorable action by the Examiner at an early date is respectfully solicited.

In the event that the present invention as claimed is not in a condition for allowance for any other reasons, the Examiner is respectfully invited to call the Applicants' representative at his Bloomfield Hills, Michigan office at (248) 540-4040 such that necessary action may be taken to place the application in a condition for allowance.

Respectfully submitted,

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